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SILVICAL CHARACTERISTICS of RED ALDER

by NORMAN P. WORTHINGTON

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PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
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SILVICAL CHARACTERISTICS OF RED ALDER

by

Norman P. Worthington

Red alder (Alnus rubra) is the largest species of the genus and a leading hardwood throughout its range. It is the most important hardwood of the Pacific Northwest and coastal Alaska. Alnus (a genus of the birch family) is from the classical Latin name for the tree (12). Occurring in groups or dense groves along water courses and sheltered coves, red alder is a typical tree of lowlands, river valleys, and moist mountain slopes along the Pacific slope (fig. 1). Throughout its range, small groups of red alder break the monotony of deep coniferous forests (4) with their smooth, tapering boles often inclining outward toward the light, and their short dome-shaped crowns. Red alder is also known as Pacific Coast alder, Oregon alder, and western alder. Its range is confined to the Pacific Coast region from southeastern Alaska to western British Columbia, and south through western Washington and western Oregon to Santa Barbara in southern California (17) (fig. 2). Red alder seldom occurs farther inland than 100 miles or above 2,500 feet elevation. Existing stands are estimated to contain 12.5 billion board-feet, of which 90 percent is in Washington and Oregon. Principal uses of alder wood, listed in order of importance are: pulp and paper, furniture, fuel, and interior finish.

HABITAT CONDITIONS

Climatic

The climate in which red alder grows may be termed humid and superhumid, according to Thornthwaite's classification (19). Primary factors limiting the range of red alder are precipitation and temperature. The tree requires an annual rainfall of 25 inches or more, unless the deficit is compensated for by nearness to the ocean or high humidity. Minimum temperatures much below 0° F., or extended periods of near zero temperature, definitely restrict its range. Over most of the tree's range, annual precipitation varies from 25 inches to 120 inches. During the summer dry period (June-September), however, rainfall may be as low as 5 inches or less. Annual temperature extremes vary from zero, or slightly below, to 105° F., or slightly higher at the southern extremity of its range (table 1).

Figure 1.--A group of mature red alder 12 to 16 inches in diameter. Clatsop County, Oregon.

FIGURE 2.--RANGE OF RED ALDER.

Table 1.--Climatological data[1/] for locations within the range of red alder (Alnus rubra)

Location	Elevation	Average annual precipitation	Average annual snowfall	Temperatures				Frost-free days
				Average July	Average January	Lowest	Highest	
	Feet	Inches	Inches	Degrees F.				Number
ALASKA								
Sitka	67	87	([2/])	54.9	32.4	-5	87	159
CANADA								
Vancouver, B.C.	22	57	29	63.7	36.2	2	92	219
WASHINGTON								
Everett, Snohomish County	120	32	10	61.6	38.3	3	98	213
Olympia, Thurston County	190	46	15	62.8	37.0	-2	104	191
Aberdeen, Grays Harbor County	12	83	12	59.7	39.4	6	105	191
OREGON								
Astoria, Clatsop County	220	78	5	60.9	40.3	10	97	273
Tillamook, Tillamook County	26	89	5	68.0	33.7	1	101	182
Newport, Lincoln County	155	66	1	56.8	43.7	1	100	248
CALIFORNIA								
Crescent City, Del Norte County	45	75	1	59.3	46.0	19	102	234
Santa Barbara, Santa Barbara County	120	18	Trace	66.1	53.0	20	115	329

1/ From U. S. Weather Bureau records in U. S. Dept. Agric. Yearbook, 1941, Climate and Man, and from other published summaries of the Weather Bureau.

2/ Not available.

Edaphic

Red alder grows on soils varying all the way from gravel or sand to clay, but requires an abundant supply of soil moisture. Although red alder tends to be more prevalent on soils of restricted internal drainage, it is not found in bottomlands subject to consistent overflow (10). Some of the more common soil series on which alder occurs are the Alderwood, Astoria, Bow, Everett, Indianola, Kapowsin, Kitsap, Melbourne, Olympic, and Squalicum. These soils are normally derived from sandstone, shale, basalt or granite parent material. Best stands occur on deep, well-drained loams or loamy sands of alluvial origin. Throughout the Puget Sound and Lower Columbia River drainages of Washington and the Coast Range of Oregon, red alder is prevalent on most alluvial soils and extends up the lower slopes until accelerated drainage limits tree development. In Alaska and northern British Columbia, stands are found on narrow bands of soil outwashed from higher elevations, and frequently as a pioneer species on fresh avalanches. California stands are confined, usually to stream courses. Soils are not a serious limitation except as they affect availability of soil moisture.

Physiographic

At the northern extremity of its range (latitude 60° N. in Alaska), red alder grows close to sea level. At latitude 56° N. in British Columbia, however, it has been found 200 miles inland east of the Coast Range, and at an elevation of approximately 2,300 feet (5). Throughout western Washington and western Oregon, it grows from sea level to 2,500 feet elevation. It seldom occurs east of the Cascade or Sierra Nevada Ranges. In California, the tree occurs mainly on the seaward side of coast ranges within the fog belt.

The best stands of alder occur under 1,500 feet elevation in Washington and northern Oregon, from Bellingham, Washington, to Florence, Oregon (latitude 49° N. to 44° N.). At lower elevations it occurs on all slopes, except that in areas of lower precipitation and higher temperatures north- and east-facing slopes are favored. Red alder seldom occurs on steep south or southwest slopes, because of moisture deficiency.

Biotic

Red alder is the major hardwood in the Pacific Transition Faunal Zone (14) in the coastal plain of North America between Sitka, Alaska, and Eureka, California. It occurs as an important tree in three cover types of western North America (16). It is the major component in the red alder type, and a minor one in the Sitka spruce and Sitka spruce--western hemlock types. Red alder is found patchwise and as single trees in the Pacific Douglas-fir, Douglas-fir--western hemlock, and western redcedar types as well. The tree occurs in most Pacific Coast coniferous forest types, but normally reaches good development only on moist sites. Pure stands are confined chiefly to lower elevations in stream bottoms, moist flats or lower slopes.

Western redcedar (Thuja plicata),[1/] western hemlock (Tsuga heterophylla), grand fir (Abies grandis), Sitka spruce (Picea sitchensis), Douglas-fir (Pseudotsuga menziessi), vine maple (Acer circinatum), bigleaf maple (Acer macrophyllum), and black cottonwood (Populus trichocarpa) are characteristic associates of red alder.

Minor tree associates are western birch (Betula papyrifera) in its northern range; cascara buckthorn (Rhamnus purshiana), and Oregon ash (Fraxinum latifolia) in the central range; and redwood (Sequoia sempervirens), Port-Orford-cedar (Chamaecyparis lawsoniana), and Oregon ash in the southern range.

Common shrubs associated with red alder are Pacific red alder (Sambucus callicarpa),[2/] blueberry elder (Sambucus cerulea), salmonberry (Rubus spectabilis), western thimbleberry (Rubus parviflorus), American devilsclub (Oplopanax horridus), and osoberry (Indian plum) (Osmaronia cerasiformis).

1/ Scientific and common names follow "Check list of native and naturalized trees of the United States (including Alaska)" (12).

2/ Scientific and common names follow: Kelsey, Harlan P., and Dayton, William A. Standardized Plant Names (2nd ed.), Harrisburg, Pa. 1942.

LIFE HISTORY

Seeding Habits

Flowering and fruiting.--Flowers in red alder are borne in the spring, are monoecious, and are produced in catkins, which were formed the preceding season and expand before or with the leaves. Staminate catkins occur in small tassel-like clusters 5 to 6 inches long and 1/4-inch thick (17). They are naked and erect during winter but become elongated and pendulous at maturity. Pistillate aments, also erect and usually naked during the winter, enlarge but slightly at flowering and develop into ovid strobiles or conelets (20). Conelets are 1/2- to 1-inch long and 1/3- to 1/2-inch thick at maturity and are dark brown in color. They contain 50 to 100 small, flattened nutlike seeds (4).

Dates of spring growth events vary over the geographic range of red alder, beginning earliest in the south, at lower elevations, and in areas close to the ocean. The following dates[3/] show the range of principal growth events for 17 Oregon and Washington stations, at elevations ranging from 200 to 1,500 feet, and for a typical station, Fortson in Snohomish County, Washington, latitude 48° N., elevation 500 feet:

Event	17 Stations (range)	Fortson (average)
Leaf buds burst	March 21-April 23	April 3
Completely leaved out	April 9-May 16	May 2
Flowering begins	February 19-May 4	March 29
Flowers all fallen	March 18-June 5	April 12
Fruit ripe	August 5-October 29	August 27
Leaves mostly fallen	Sept. 18-November 24	November 13

Seed production.--Red alder seed production begins at approximately 10 years of age (6 to 7-inches d.b.h.) and continues to maturity. Optimum seed-bearing age is 25 years (10 to 12 inches d.b.h.). Most trees in a stand produce cones since red alder seldom survives unless it maintains a dominant or codominant crown position. Red alder is a prolific seeder, bearing good seed crops about every fourth year with light crops in intervening years. Absolute seed crop failure is an extreme rarity, but may

3/ Source: Unpublished data, Pacific Northwest Forest and Range Experiment Station, Portland, Oreg. December 9, 1952.

occur as in 1956 following the severe November 1955 freeze. Yield of cleaned seed per bushel of cones is approximately 1.12 pounds, averaging 666,000 seeds per pound (20). Alder seed, though not usually a preferred food of the deer mouse, is readily gleaned by them from the snow surface when other food is difficult to obtain (15). No other animals or insects are known to substantially reduce potential seed crops.

Seed dissemination.--Seed dispersal begins shortly after conelets ripen in September and continues through the fall and winter. Natural seed fall is commonly observed on fresh snow in late fall and early winter. The seed is light and is carried great distances by wind. Wind dissemination is so effective that abundant seed for natural regeneration is normally assured throughout the range of red alder.

Vegetative Reproduction

Young red alder trees sprout vigorously from the stump, depending on the season cut. Older trees, however, seldom sprout and the coppice method of regeneration cannot be relied upon after merchantable trees are harvested. Cuttings do not root easily.

Seedling Development

Establishment.--Records of red alder germination are scanty. Germination rates in two tests were 14 and 40 percent, while numerous tests of A. glutinosa and A. incana gave maximum germination of over 80 percent. Germination usually begins 45 days after nursery sowing (20).

Alder seeds germinate freely under field conditions. They prefer mineral soil, although seedlings can become established on litter. Full overhead light is required for best results. Young seedlings can tolerate partial shade up to 2 or 3 years, but after that full overhead light is necessary. Abundant soil moisture and cool temperatures are important prerequisites for red alder establishment. Natural enemies of alder seedlings are not serious, and abundant survival is normal.

Red alder regeneration will probably be favored by either clear cutting or large group cutting (6). Any method providing full overhead light and considerable exposure of mineral soil will safely reproduce the tree if adequate moisture is available.

Early growth.--First year development of red alder seedlings is rapid. The root system quickly penetrates into mineral soil and develops lateral roots. Where moisture is adequate, first year shoots are 6 to 18 inches in length. Subsequent height growth is even more rapid. Average 5-year-old seedlings on good sites are 15 feet, while 10-year-olds may be 35 to 40 feet. After approximately 10 years, height growth slows down to 2 to 2-1/2 feet per year.[4/]

This rapid initial height growth permits red alder to overtop all conifer associates during early development. Red alder is usually the first tree species to become established in areas where moisture conditions are at all favorable for it. Whether such occupancy is temporary or not depends upon continuance of normal height growth. At approximately 25 years, Douglas-fir, its chief competitor, usually overtakes it in height.

Seasonal radial growth begins before height growth. At the McCleary Experimental Forest, Grays Harbor County, Washington, radial growth began on April 7 in 1955 and on May 6 in 1954 (late growing season). Radial growth continued for an average period of 130 days, which was somewhat longer than height growth. Time and period of growth were essentially the same as for Douglas-fir.

Sapling Stage to Maturity

Growth and yield.--Red alder is the largest of the six alders of North America. The largest known living tree is 34 inches in diameter and grows in Olympic National Park, Washington (1). Range of maximum tree size on better sites is 24 to 30 inches in diameter and 100 to 130 feet in height. These larger trees contain 800 to 1,500 board-feet Scribner rule (7). Often excessively large-diameter trees have short merchantable boles not suitable for lumber production. Red alder, even on best sites, is exceeded in height and diameter by cottonwood at any comparable age, and by conifers after the first 50 years. Red alder is short-lived, with a maximum age of approximately 100 years.[5/] However, red alder stands on the better sites reach a maximum volume at 50 to 70 years.

4/ Lloyd, William J. Contrasting characteristics of Douglas-fir and red alder as affecting the management of mixed stands. Paper presented at Northwest Scientific Association meeting. December, 1952.

5/ Unpublished data from Pacific Northwest Forest and Range Expt. Station, Portland, Oregon.

Red alder growing on a good site in the Puget Sound area may be 18 feet tall at 5 years, 40 feet at 10 years, and 65 feet at 20 years. Under normal forest conditions for good sites in the North Puget Sound area, trees may reach the following heights and diameters (10):

Age (years)	Height (feet)	Diameter, breast height (inches)
25	78	10
30	82	11
35	86	12
40	90	13
45	94	14
50	98	16
55	101	17
60	105	18

Red alder occurs not only in pure stands but also as scattered small groups, or single trees in coniferous stands. Over extensive areas, not over one-third of the red alder volume normally occurs in pure stands; the remainder occurs in stands dominantly coniferous. Reliable data on growth and yield are not available. The best examples are shown in table 2. Where red alder grows in pure or nearly pure stands, yields of 5,000 to 6,500 cubic feet and 20,000 to 30,000 board-feet Scribner per acre are possible at age 50-70 years.[6/] Mixed stands containing 500 to 3,500 board-feet Scribner of red alder per acre, representing 5 to 12 percent of the total stand volume are more common.[7/]

Reaction to competition.--Alder is generally considered an intolerant tree, though opinion is divided (2). It is less tolerant than bigleaf maple, Douglas-fir, western hemlock, western redcedar, and grand fir, but more tolerant than cottonwood, quaking aspen, and western birch.

When growing in pure stands, most trees that fail to maintain a position in the upper crown canopy quickly die from lack of light. Thinning at an early age is recommended to salvage this mortality. A pure, 26-year-old stand responded well to release by thinning in the first 6 years following treatment (13).

6/ Unpublished Forest Survey data. Pacific Northwest Forest and Range Expt. Sta., Portland, Oreg.

7/ Unpublished data on file at Puget Sound Research Center, Pacific Northwest Forest and Range Expt. Sta., Olympia, Wash.

Table 2.--Examples of red alder mean annual increment and total yield in the Pacific Northwest

Location	Age of stand	Yield		Mean annual increment		Basis
		Cubic feet	Board-feet	Cubic feet	Board-feet	
Western Oreg. and Wash.[1/]	47	4,500	21,663	103	480	16 selected 1/5-acre plots, pure alder type
Siuslaw N.F., Lane County, Oreg.[2/]	60	--	10,510	--	175	Inventory of 2,000 acres of 60-year stands
Soil Conserv. Serv., Snohomish[3/]	32	4,388	--	137	--	4 selected 1-acre, pure alder plots
McCleary Expt. Forest, Grays Harbor County, Wash.[4/]	45	4,650	20,395	103	453	Inventory of 100-acre stand with 31 percent conifer mixture
Large private land holdings, SW Wash.[5/]	50	2,660	--	53	--	150 1/5-acre plots mechanically spaced within hardwood types

1/ Johnson, Herman M., Hanzlik, Edward J., and Gibbons, William H. Red alder of the Pacific Northwest, its utilization with notes on growth and management. U. S. Dept. Agric. Bul. 1437. 1926.

2/ Aufderheide, Robert. Some notes on alder management. Unpublished manuscript on file at Pacific Northwest Forest and Range Expt. Sta. 1950.

3/ Lloyd, William J. Alder thinning progress report. Tech. Note, Woodland Conserv. No. 3, Soil Conserv. Serv., Portland, Oreg., 1955.

4/ Worthington, Norman P. Fourth annual supplement to Mc Cleary Experimental Forest Management Plan. Pacific Northwest Forest and Range Expt. Sta. 1953.

5/ Data on file at Puget Sound Research Center, Olympia, Wash.

Limiting factors.--For about the first 40 years of age, red alder is exceptionally free from disease and other damaging agents (10). White heart rot (Fomes igniarius) is the most destructive disease of the live tree and is particularly prevalent on injured trees and in overmature stands. The cankers (Didymosphaeria oregonensis and Hymenochaete agglutinans) attack young trees causing some deformation and stunting of growth, but aggregate damage is slight (3).

Two tent caterpillars (Malacosoma pluviale and M. disstria), a sawfly (Hemichroa crocea), and a flea beetle (Altica ambiens) periodically consume red alder foliage over considerable areas. Such defoliation presumably decreases growth in the year of attack, but is of no great importance because outbreaks soon subside and practically all the trees recover. The alder bark beetle (Alniphagus aspericollis) commonly attacks and kills trees weakened by other causes. Flat-headed borers and ambrosia beetles of several species mine in the wood of seriously weakened red alder, but do not themselves kill trees (11).

Damage by fire is unusual because inflammable debris is usually scarce under a red alder stand. The bark, although thin, is sufficiently fire resistant to protect the tree from light surface fires. Often red alder serves as a firebreak to protect adjacent conifer stands from fire damage (9).

SPECIAL FEATURES

The nodules on red alder roots are reported to foster nitrogen-fixing organisms (Schinzia alni)[8/] and the leaves build humus, thus adding to the fertility and moisture holding capacity of lighter soils (8) (18).

Red alder is prone to form epicormic branches from dormant buds, particularly if a sudden increase of light is introduced. There may be other factors not yet known that account for this phenomenon (21).

8/ Krajina, Dr. Vladimir J. Some ecological observations on Weyerhaeuser Tree Farms, May 10-June 25, 1954. Unpublished mss.

RACES AND HYBRIDS

Thus far no evidence of races in red alder have been uncovered. A rare variety (A. rubra pinnatisecta) has been reported in Snohomish County, Washington, 9/ at two widely separated points on Vancouver Island, and near Portland, Oregon (5).

Red alder has been crossed with the European Alnus glutinosa by Swedish workers, and the resultant hybrids exceed A. glutinosa in height growth. Main objectives of the Swedish improvement work have been to increase height growth and improve stem form, as well as to develop trees that show little tendency to adventitious sprouting and suckering. Swedish geneticists have found alder easy to work with because it flowers early and regularly, grafts easily, produces abundant pollen and seed, and is generally self-fertile (8).

CONCLUSION

Much more research and investigation will be needed to provide complete information on the silvical characteristics of red alder. Until very recently red alder has been so little used commercially that there was slight incentive to learn more about it. Now, however, the expanding use of red alder in pulp and paper manufacture and in the California furniture trade makes it the leading commercial hardwood of the Pacific Northwest. As the management of our Pacific Northwest forests is intensified to utilize more fully their productive capacity, so will our need for knowledge of red alder increase.

9/ Reported by William J. Lloyd, Soil Conservation Service, Seattle, Wash.

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